

B.TECH. DEGREE EXAMINATION, NOVEMBER 2014**Third Semester**

Branch—Electronics and Communication/Applied Electronics and Instrumentation/
Electronics and Instrumentation Engineering

SOLID STATE DEVICES (L A S)

(Prior to 2010 Admissions—Old Scheme)

[Supplementary/Mercy Chance]

Time : Three Hours

Maximum : 100 Marks

Part A

*Answer all questions briefly.
Each question carries 4 marks.*

1. Distinguish between direct and indirect bandgap semiconductors ? Give examples.
2. Explain the conduction process by holes.
3. List and briefly explain the properties of depletion region of a pn junction.
4. What are the differences between Zener and Avalanche breakdown ?
5. What is a varactor diode ? What are its applications ?
6. Draw the VI characteristics of a tunnel diode and label it.
7. Explain the doping profile in BJT and what is its significance.
8. What is Schottky transistor ? What are its applications ?
9. Define :
 - (i) pinch-off voltage ;
 - (ii) threshold voltage ;
 - (iii) saturation voltage ; and
 - (iv) breakdown voltage of a JFET.
10. What are the precautions to be taken while handling MOSFET ? Why ?

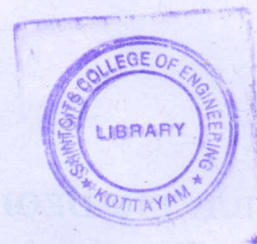
(10 × 4 = 40 marks)

Part B

*Answer all questions.
Each full question carries 12 marks.*

11. In a semiconductor at room temperature of 27°C , the intrinsic carrier concentration and resistivity are $1.5 \times 10^{16} / \text{m}^3$ and $2 \times 10^3 \Omega\text{m}$ respectively. It is converted to an extrinsic semiconductor with a doping concentration of 10^{20}m^3 . For extrinsic semiconductor calculate :

Turn over



- (a) Minority carrier concentration ;
- (b) resistivity ;
- (c) shift in Fermi-level due to doping ; and
- (d) Minority carrier concentration when its temperature is raised to a value at which intrinsic carrier concentration doubles. Assume $\mu_n = \mu_p = 2000 \text{ cm}^2/\text{Vs}$, $kT = 26 \text{ mV}$ at room temperature.

Or

12. (a) Derive the expression for the minimum conductivity of a semiconductor.
 (b) Explain the transient decay of excess carriers in a semiconductor with direct recombination. Explain minority carrier life time.
13. In a p^+nn^+ junction diode, made of silicon the doping concentration of n -region is $5 \times 10^{15} / \text{cc}$. If the circuit field at avalanche breakdown is $3 \times 10^5 \text{ V/cm}$, find :
- (a) the breakdown voltage if the width of n -region is (i) $10 \mu\text{m}$; (ii) $5 \mu\text{m}$; (iii) $1 \mu\text{m}$.
 - (b) Sketch and label the electric field distribution.

Or

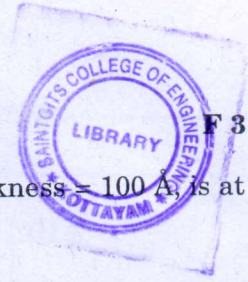
14. Sketch the profiles and derive expressions for :
- (i) build-in potential ;
 - (ii) electric - field distribution ;
 - (iii) depletion layer capacitance of a linearly graded p - n junction.
15. (a) Derive expression for the time variation of voltage across a p - n junction as it is switched from forward-bias to reverse-bias condition. (8 marks)
- (b) Draw the characteristics of a tunnel diode and explain. (4 marks)

Or

16. (a) Derive the expression for conductance of a diode. How does it vary with variation in forward-bias ?
- (b) What is Zener diode and how does it regulate the voltage ?
17. Plot the minority carrier distribution in a p - n - p BJT in all the three regions and label it properly for (i) active region ; (ii) cut-off region ; and (iii) saturation region.

Or

18. Draw the n - p - n and p - n - p transistors. Label all the currents when biased in active region and show the direction of carrier flow in both types of transistors ? Derive expressions for the current components.



19. A silicon MOS system with p -type substrate with $N_A = 10^{15}/\text{cc}$, oxide thickness = 100 \AA , is at the onset of strong inversion. Determine :

- (a) width of depletion layer ;
- (b) the charge density in the depletion layer ;
- (c) the electron density n_s at the surface ; and
- (d) the threshold voltage. Assume $\epsilon_{\text{rox}} = 3.9$, $n_i = 1.5 \times 10^{10}/\text{cc}$.

Or

20. Derive expression for the drain current of JFET. What are the approximations made ? Explain the effect of increase in temperature on the drain current.

(5 × 12 = 60 marks)